Feasibility of an All Silage Forage Program

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Interest in all silage forage programs has increased for the following reasons: a) In areas where hay curing is difficult and field-curing losses are high, silage offers a method of circumventing these problems. b) Silage feeding is easier to automate and more easily incorporated into a complete ration program than is hay feeding. c) In areas where corn can be grown, corn silage offers the potential of maximizing production of energy per acre. The all silage forage program can range from a combination of silages during the winter period to the use of one silage for the entire year. Results and possible problems would vary with the system selected and the level of milk production desired.

Use of an all silage forage program would be more readily accepted if the dairyman could be assured that such a program would maintain maximum milk production, animal health, and profit over a period of years. At present, it is still accepted and recommended by some authorities that some high-quality hay be included in all forage programs.

There are numerous reports comparing all legume-grass silage feeding programs with hay programs or combination hay and grass silage programs for short periods of time. Some of the reports (10, 15, 20) have indicated that an all silage forage program was inferior to feeding regimes of high quality hay or a combination of hay plus silage. In these trials both forage intake and milk production were lower for the silage fed cows. In the report of Gordon et al. (15), where both direct-cut silage and haylage were compared with barn dried hay, haylage (39-53% dry matter) improved dry matter intake over the direct cut silage (24-27% dry matter), but did not improve milk production. In a later report (14) by the same group, silage wilted to 38-45% dry matter was equal to heat-dried hay harvested from the same field, in both dry matter intake and milk production.

Whereas dry matter intake is generally lower for silage-fed cows, the majority of reports (1, 3, 5, 14, 32, 34) have shown that milk production is as high—and sometimes higher—on the silage program as it is on a hay program. Since dry matter intake is positively related to dry matter content at ensiling (13), better results should be expected from the feeding of higher dry matter silages. However, there are indications that as the dry matter is increased, nitrogen utilization is decreased. Owen and Howard (30) and Gordon et al. (15) have reported a decrease in the digestion coefficient of crude protein with low-moisture silages. Both feeding studies were conducted with high crude protein forage and no effect was noted on milk production. It is possible that if protein were limiting, low moisture silages would need additional protein supplementation.

Silage was more consistently inferior to hay feeding when compared in intake and growth studies with heifers (24, 26, 31, 35–39). An increase in the dry matter content at ensiling of the silage improves growth (14) and can result in as good, or better, gains than barn dried hay. Since energy intake can be increased rather easily by grain supplementation when low dry matter silages are fed, additional grain may be required to maintain the desired growth rate of heifers.

Corn silage has been compared with alfalfa hay and with combinations of hay and corn silage (4, 33). In both studies dry matter intakes decreased as level of silage increased; however, milk production increased slightly with increasing levels of silage feeding. In other reports (17, 21), where corn silage was fed as the only source of forage, dry matter intake increased as stage of maturity increased. It would appear that with a high-energy forage, such as corn silage, there should be little problem in obtaining a good energy intake and maintaining high levels of production. The limitations of increasing dry matter content of corn silage are not clearly defined at present. Byers et al. (6) have studied mature corn harvested and ensiled at 55% dry matter and obtained milk production results about equal to silage harvested at 32% dry matter when fed in a combination with hay. They did note a decrease in digestible dry matter, 56.7%, as compared to 62.7% for a 32% dry matter corn silage.

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The majority of trials comparing silage feeding to a hay program have included relatively low levels of concentrates. It is possible that some of the differences noted above would be decreased when fed with the high levels of concentrate feeding currently being practiced on many farms.

Studies to find the basic cause of lower dry matter intake rates when silages have been compared to hay have been relatively unsuccessful. Some factors not found to influence intake rates are pH (20), histamine levels (29), added water (20, 36), organic acids (36), and a number of other materials (36). In a recent report by Waldo et al. (40), it was concluded that rumen retention time was not a controlling factor, although previous work by Campling (7) had suggested that passage of silage from the rumen was slower than that for hay.

The difference in energy value or energy utilization of the two forms of forage may explain the apparent discrepancy of lowered intake rates and higher milk production with silages as compared to hays. Ekern and Reid (12) found a greater output of metabolic heat for hay diets and suggested that diets resulting in a high proportion of propionic and butyric acids relative to acetic acid in the rumen may be responsible for greater efficiency. Whereas Ekern and Reid found dry matter and energy digestibility to be about equal, as do other workers (14, 34), Waldo et al. (39) report a lower dry matter digestibility for silage as compared with hay. They also report a higher gross energy value for silage as compared with hay and suggest other reports may have been biased downward in energy digestibility, because of differences in techniques for measuring the gross energy value for silages. In an abstract prepared for publication, Waldo et al. (41) report equal dry matter digestibility but appreciably higher digestible energy values for a silage with formic acid added. Techniques used to measure dry matter and gross energy values of hay and silage may be critical, if some of the differences in relative efficiency between hay and silage programs are to be evaluated correctly.

Long-term experiments with an all silage program have been reported in only a few studies. Use of an all corn silage ration was reported by Converse and Wiseman (11) in 1952. Their study did not compare the corn silage program with a combination hay or pasture program. The daily intake from silage ranged from 7.8 to 16.6 kg, considered low by most of our present studies. They reported that these results demonstrated that an all corn silage program would maintain milk production. They also demonstrated that heifers could be raised on an all-corn silage-feeding regimen.

Recently, two stations (4, 18, 19) have reported preliminary results on the comparison of an all-corn silage program with a hay or combination hay and silage program over complete lactations. Results look encouraging for corn silage programs at their present stage of progress. Michigan (4) has reported lower forage dry matter consumption as the level of corn silage is increased in the ration. Milk production trends were in the opposite direction of the forage intake values. Average level of milk production was 23.8 kg for the all silage group for the 280-day period. Maintenance of high levels of milk production such as this indicates that high-producing cows can maintain excellent production under this system. It would be helpful if more research with dairy cows were conducted with production levels which could be classified as excellent.

Our own results are based on a three-lactation experiment currently being conducted, in which cows fed corn silage as the sole forage during the entire year are compared to those receiving half of their forage dry matter from corn silage and half from alfalfa hay. Each of the forage groups is split into three subgroups of five cows and each subgroup fed concentrates at a different level. One subgroup is offered additional concentrates, to provide 110% of the recommended milk production allowances (Morrison's Standard, ENE); the second is fed to 125% of the recommended milk production allowances; the third to 140% of these allowances. In addition, all groups receive 100% of the recommended allowances for growth, maintenance, and pregnancy. These six groups of cows are fed their forage ad libitum.

In addition to the above six groups, two groups are being fed limited forage and additional concentrates to 140% of the recommended allowances for milk production, plus 100% of the recommended allowances for growth, maintenance, and pregnancy. One group is receiving 1 kg of alfalfa hay per 100 kg of body weight and the other 0.9 kg of corn silage dry matter per 100 kg of body weight.

Cows receiving only corn silage are being fed an 18% protein concentrate mix and those receiving both corn silage and hay a 14% protein mix. Both of these mixes are composed

TABLE 1

Average milk production and composition for first year of Maryland experiment

Ration group[a]	305-Day		Experimental period			
	Milk	Fat	Milk	Fat	Fat	SNF
	(kg)		(kg)		(%)	
Hay and corn silage	6,204	233	3,795	141	3.74	8.82
Corn silage	6,113	244	3,580	142	3.96	8.89
Limited forage	6,272	221	3,879	124	3.19	8.86
110% Feeding level	6,020	240	3,554	143	4.02	8.96
125% Feeding level	6,326	239	3,759	140	3.73	8.87
140% Feeding level	6,130	236	3,728	141	3.78	8.83

[a] Hay and corn silage group and the corn silage group include subgroups which received grain at 110, 125, and 140% level; limited forage group includes the limited hay and limited silage subgroups; and feeding-level groups include both the hay and corn silage group and the corn silage group.

of shelled corn, barley, soybean oil meal, and minerals.

Milk production during the last part of the first lactation was very similar for all groups, as shown in Table 1. The limited forage groups exhibited a depression in milk fat when compared with groups receiving larger amounts of forage. Results from the second year again show little difference in milk production, although production was slightly higher for the corn-silage-fed groups. The depressing effects of limiting forage and increasing grain on milk fat are demonstrated. The failure to obtain greater production by increasing feeding levels is explained primarily as the inability of all groups to eat the grain offered during the first 16 wk of the trial (18). The third lactation in the studies is now in progress, but it is too early to predict any results other than that the average level of milk production appears to be improved over the second year.

If we accept that level of intake and milk production can be maintained over long periods of time with only one silage as a source of forage, then we should look at some possible problems which have occurred or have been suggested. Several areas suggested are: a) nutrient deficiency, such as vitamin A or a mineral deficiency, b) difficulty in maintaining forage intake because cattle tire of the ration, and c) possible physiological effects from the absence of dry roughage.

Our own results would indicate that in addition to calcium, phosphorus, and salt, iodine is also needed. Maryland is not considered in the Goiter Belt, however, after the first lactation we observed that three of the first four cows to calve produced calves with goiters. Iodized salt was then added and one cow, after receiving iodized salt for about two weeks, produced a calf with a small goiter. All cows which produced calves with goiters, except the last one, which had received iodine for a short period, had retained placentas. Preliminary iodine analysis of the alfalfa hay and corn silage fed during the period when the goiters were observed showed little difference in iodine content. The hay had an iodine content of 18 parts per billion and the corn silage 22 parts per billion.

Two reports (27, 28) have shown a relationship between an iodine deficiency with retained placentas or other breeding problems. Our original ration does not appear to be deficient. Another possibility suggested by other reports (2, 8) is a relationship between thyroid activity and nitrate levels. It is, therefore, possible that addition of iodine has overcome

TABLE 2

Average milk production and composition for second year of Maryland experiment

Ration group[a]	Milk	Fat	Fat	SNF
	(kg)		%	
Hay and corn silage	6,164	229	3.62	8.46
Corn silage	6,384	249	3.86	8.76
Limited forage	5,948	203	3.38	8.57
110% Feeding level	6,567	255	3.93	8.57
125% Feeding level	6,432	235	3.65	8.67
140% Feeding level	6,151	226	3.65	8.59

[a] Grouped the same as in Table 1.

TABLE 3

Feed intakes for second year of Maryland experiment

Ration group[a]	Grain	Hay	Silage	Silage dry matter
		(kg)		
Hay and corn silage	9.8	3.4	13.2	4.4
Corn silage	9.7	....	22.2	7.1
Limited forage				
Hay group	10.0	5.4	.....	....
Silage group	9.5	....	13.8	4.4
110% Feeding level	8.5	2.0	20.2	6.5
125% Feeding level	10.3	1.2	16.0	5.0
140% Feeding level	10.3	2.0	16.8	5.7

[a] Grouping described in Table 1.

the detrimental effect of nitrate or some other factor(s). It is also of interest that in the long term silage feeding study of Converse and Wiseman (11) they observed one calf with complications of goiter. We have concluded that additional iodine is needed to prevent goiter and retained placentas, with corn silage produced under conditions such as ours. These results raise the question of the possible deficiency or interference of other trace elements when reliance is place on only one forage; however, we have not observed any other problems at present.

Vitamin A has been suggested as a possible problem with all-corn silage rations; however, results from Michigan (4) suggest this should not be a problem. We have checked blood vitamin A and carotene content of our cows. Our average values are a little lower than those from Michigan; however, there does not seem to be a clear pattern between those cows receiving hay and corn silage and those receiving corn silage. Values below 10 μg/100 ml have been noted primarily with cows shortly after calving. Results from Illinois (23) have indicated a poor conversion of carotene to vitamin A when corn silage is fed to beef cattle. The basic cause for this poor conversion is still unknown, but several groups are currently studying this problem. In any event, it would be easy to supplement corn silage rations with additional vitamin A if a future work shows the necessity.

With all-corn silage rations, one of the problems in feeding the herd is the difficulty of maintaining adequate protein intake at lower levels of grain intake. At Maryland, we have replaced part of the 18% crude protein ration with soybean oil meal, to maintain adequate protein intake for some of our cows at the later stages of the lactation. Therefore, use of urea or some other protein in the silage would help overcome this difficulty. At present, results on urea supplementation for corn silage are not all in agreement. Huber et al. (22) have reported lowered intakes of silage and lowered milk production when urea replaced soybean oil meal. They mixed the urea with the corn silage at feeding time. Michigan workers (25) have reported good results from addition of urea at ensiling. Some of these differences may be explained by results reported with beef cattle from Illinois (9, 16). They have found better animal performance when urea is added at ensiling, when compared to addition at feeding. Illinois has also reported that even when added at ensiling, results were not as good as soybean oil meal supplementation. With most legume or legume grass mixtures protein would not be a problem.

Results from the second lactation and partial results from the third lactation do not indicate any problem with lowered intakes after several lactations. Intake rate of energy during the peak months of lactation were actually slightly higher for the cows receiving only silage, as compared with those receiving both hay and silage.

Other possible physiological problems, such as breeding efficiency, have not been thoroughly studied. After the completion of three lactations, we may be better able to summarize these results.

We would conclude that an all silage forage program is feasible and has been successful to date. While some operations currently do not have silage storage space to go to such a program, there do not seem to be any deterrents for those who wish to move in that direction. A recent report by Owen and Howard (30) would also indicate that an all silage forage program could also be incorporated into a complete feed program. While few dairymen would probably go to one silage as the only forage, work at both Michigan and Maryland demonstrate that corn silage is at least

equal to an all hay or hay plus corn silage program.

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